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APPLICATION NUMBER: ***60/551,632***
FILING DATE: ***March 07, 2004***
RELATED PCT APPLICATION NUMBER: ***PCT/US05/06142***

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PROVISIONAL APPLICATION FOR PATENT COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c).

Express Mail Label No. EV 147307560 US

INVENTOR(S)

Given Name (first and middle [if any])	Family Name or Surname	Residence (City and either State or Foreign Country)
HUI	WANG	FREMONT, CALIFORNIA

Additional inventors are being named on the 1 *separately numbered sheets attached hereto*

TITLE OF THE INVENTION (500 characters max)

METHODS AND APPARATUS FOR CONTROLLING THE REMOVAL RATE DURING ELETROPOLISHING

Direct all correspondence to: **CORRESPONDENCE ADDRESS**

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Address	46520 FREMONT BLVD., SUITE 610				
Address					
City	FREMONT	State	CA	Zip	94538-6478
Country	UNITED STATES	Telephone	(510) 445-3700	Fax	(510) 445-3708

ENCLOSED APPLICATION PARTS ***(check all that apply)***

☑ Specification *Number of Pages* 10 ☐ CD(s), Number

☑ Drawing(s) *Number of Sheets* 18 ☑ Other (specify) RETURN RECEIPT POSTCARD

☑ Application Data Sheet. See 37 CFR 1.76

METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT

☑ Applicant claims small entity status. See 37 CFR 1.27.

☑ A check or money order is enclosed to cover the filing fees.

☐ The Director is herby authorized to charge filing fees or credit any overpayment to Deposit Account Number: ____________

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The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

☑ No.

☐ Yes, the name of the U.S. Government agency and the Government contract number are: ____________

Respectfully submitted,

SIGNATURE ____________ Date MARCH 7, 2004

TYPED or PRINTED NAME (DAVID) HUI WANG

REGISTRATION NO. ____________ *(if appropriate)*

Docket Number: ____________

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USE ONLY FOR FILING A PROVISIONAL APPLICATION FOR PATENT

PROVISIONAL APPLICATION COVER SHEET
Additional Page

Docket Number

INVENTOR(S)/APPLICANT(S)

Given Name (first and middle [if any]	Family or Surname	Residence (City and either State or Foreign Country)
MUHAMMED	AFNAN	Dalian, Liaoning Province, China
JIAN	WANG	FREMONT, CALIFORNIA
FELIX	GUTMAN	SAN JOSE, CALIFORNIA
FREDRICK	HO	SAN JOSE, CALIFORNIA
HIMANSHU J.	CHOKSHI	FREMONT, CALIFORNIA

METHODS AND APPARATUS FOR CONTROLLING THE REMOVAL RATE DURING ELETROPOLISHING

INTRODUCTION

The present invention relates generally to a method and apparatus for controlling the removal rate during electropolishing metal layers on semiconductor wafers.

SUMMARY OF INVENTION

One aspect of the present invention relates to a method of controlling the removal rate by maintaining the constant physical viscosity and constant electrolyte flow rate through the polishing nozzle. The constant physical viscosity is maintained by keeping stable composition of electrolyte and adjusting temperature of electrolyte. The stable composition of electrolyte is maintained by keeping the water content inside electrolyte constant.

In accordance with another aspect of the present invention, the bubbles generated during the polishing can be removed through a system of specially designed location of flow inlet, drain line, and flow path of electrolyte inside electrolyte reservoir

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

In order to provide a more thorough understanding of the present invention, the following description sets forth numerous specific details, such as a specific material, parameters, and the like. Additionally, the subject matter of the present invention is particularly suited for use in connection with electroplating and/or electropolishing of semiconductor workpieces or wafers. As a result, exemplary embodiments of the present invention are described in that context. It should be recognized, however, that such description is not intended as a limitation on the scope, the use or applicability of the present invention, but is instead provided to enable a more full and a more complete description of the exemplary embodiments.

Fig. 1 shows an electropolishing mechanism consists of wafer chuck 1002, wafer 1004, moving mechanism to rotate and laterally translate wafer chuck 1002, electrolyte nozzle 1010, moving mechanism 1012 to laterally translate nozzle 1010, and electrical power supply 1018 connecting with wafer 1004 and nozzle anode 1014. For a more detailed description of the electropolisher, see U.S. Letter Patent No. 6,395,152, entitled METHODS AND APPARATUS FOR ELECTROPOLISHING METAL INTERCONNECTIONS ON SEMICONDUCTOR DEVICES, filed on July 2, 1999, the entire content of which is incorporated herein by reference. Also see U.S. Provisional Application Ser. No. 60/462,642, entitled METHODS AND APPARATUS FOR OPTIMIZING ELECTROPOLISHER, filed on April 14, 2003, the entire content of which is incorporated herein by reference, disclosing variety of nozzle shape designs to enhance removal rate profile of nozzle during electrical polishing process.

The contact areas of electrolyte column with wafer at different flow rate and/or viscosity are shown in Figs. 2A through 2D. Figs. 2A and 2B show contact area 2009 of electrolyte column 2008 with wafer 2004 when electrolyte flow rate is small and/or viscosity of electrolyte is high. By increasing electrolyte flow rate and/or reducing viscosity of electrolyte, the contact area 2009 increases as illustrated in Figs. 2C and 2D. This is the result of flow dynamic of electrolyte.

Fig. 3 shows a typical relationship between removal rate and electrical current by employing electropolishing mechanism disclosed in Fig.1. As the electrical current increases to the electrical polishing region, the slope of removal rate starts level out and the polishing efficiency (defined by removal rate/amp) is reduced as shown in Fig. 3.

At constant polishing current, the polishing current density will reduce as the contact area of electrolyte column with wafer increases. According to the teaching in Fig.3, the lower current density will result in a higher polishing efficiency. Thus, the removal rate will increase when the contact area of electrolyte with wafer increases as shown in Fig. 4, assuming the current is at constant. It is important to keep a steady contact area of electrolyte column with wafer in order

to have a constant removal rate. The contact area of electrolyte column with wafer is affected by electrolyte viscosity, flow rate, and gap between wafer and nozzle.

Fig. 5 shows the relationship between physical viscosity of electrolyte and contact area of electrolyte with wafer at the constant flow rate of electrolyte. A higher viscosity results in a smaller contact area of electrolyte column with wafer due to the flow dynamic nature of liquid. For that reason, it can be concluded that higher viscosity will result in a lower removal rate as shown in Fig. 6. In order to have a stable removal rate, the physical viscosity of electrolyte should be controlled at a constant level. It should be mentioned that a higher flow rate will result in a larger contact area of electrolyte column with wafer. Therefore, flow rate should be kept at a constant level in order to have a constant removal rate.

I. TO MAINTAIN A CONSTANT VISCOSITY OF ELECTROLYTE

Viscosity of electrolyte is determined by two major parameters: (1) temperature of electrolyte; and (2) the composition of electrolyte. Fig. 7 shows the relationship between physical viscosity of electrolyte and temperature of electrolyte. It is clear that higher temperature results in a lower viscosity. A close loop control for a constant viscosity can be achieved by adjusting the temperature of electrolyte.

In a typical electropolishing electrolyte of acid base, salt base, or alkali base, water is easily removed from, or added into, electrolyte by either evaporation or absorption. An increase of water content in electrolyte will generally result in the reduction of viscosity of electrolyte. Therefore, a constant water-electrolyte balance is critical for maintaining a constant viscosity. The key is to measure the water content in electrolyte in order to control water-electrolyte balance.

The present invention discloses a method to measure the water content in electrolyte by using temperature compensated viscosity meter. Since the temperature compensated viscosity (Tcv) factors out the temperature impact to viscosity as shown in Fig. 8, Tcv can be used to indirectly measure the water content in electrolyte as the change is shown in Fig. 9.

One particular embodiment of the present invention is a full close loop automatic control system of viscosity and water content, which is disclosed in Figs. 11A through 11C. The system consists of electrolyte reservoir 11076, viscosity meter 11050, temperature sensor 11054, computer 11072, temperature control unit 11074, heating/coolant pipe 11060, electrolyte outlet 11062, 11084, 11066, electrolyte return inlet 11068, water dosing inlet 11056, and water dosing control valve 11058. The temperature of electrolyte reservoir is set at a certain level so that the water evaporation rate is slightly higher than the water absorption rate. Water content can be controlled at a constant by dosing water into electrolyte reservoir. The absorption rate and evaporate rate depend on ambient moisture and temperature surrounding electrolyte and/or electrolyte reservoir.

For example, for phosphoric-based electrolyte, the water evaporation rate is higher than water absorption rate if the temperature of electrolyte reservoir is set at 35 °C with ambient temperature of 20 °C and moisture 70%. Computer 11072 then sends the temperature set point to temperature control unit 11074. Temperature unit will adjust its coolant temperature based on the reading from temperature sensor 11054. The control mechanism can be a typical PID (proportion, integration, and deviation) control method. Next, viscosity meter 11050 sends data regarding the temperature compensated viscosity back to computer 11072. Computer sends signals to turn on water dose valve 11058 if the temperature compensated viscosity is lower than the set point. The dose amount can be set based on pre-calibration data shown in Fig. 9 or based on the particular PID method being used. By using this close water dose control mechanism, the water content can be measured and controlled at a certain value with minimum deviations.

In another aspect of the present invention, the physical viscosity of electrolyte in the reservoir 11076 can be measured by viscosity meter 11050 and sent back to computer 11072. If the physical viscosity of electrolyte is higher than a set point, computer will send a lower temperature set point to temperature control unit 11074 based on pre-calibrated data shown in Fig. 7. Similarly, if the physical viscosity of electrolyte is lower than a set point, then computer will send a higher temperature set point to temperature control unit 11074 based on pre-

calibrated data shown in Fig. 7. Again, it must be mentioned that a PID control method can be employed here in the current of aspect of the present invention.

In summary, a stable physical viscosity during a brief duration can be reached through temperature adjustment, and for a longer duration, stable physical viscosity can be reached by keeping constant water content in electrolyte.

II. CONSTANT FLOW RATE OF ELECTROLYTE

Fig. 13A shows how electrolyte passes through the supply line and into the polishing chamber 13002. As shown in Figs. 13A and 13B, pump 13014 operated by compressed air pumps electrolyte from electrolyte reservoir 13020. The same compressed air line operates surge suppressor 13012. Surge suppressor 13012 acts as a cushion to reduce the pressure pulses of electrolyte being pumped through the supply line. Electrolyte can be filtered by filter 13022.

As shown in Figs. 13A and 13C, electrolyte passes through flow meter 13016, which measures the flow of electrolyte as it passes and said flow meter sends signal proportional to such flow rate to the control system 13018.

From flow meter 13016, electrolyte reaches pneumatic ON/OFF valve 13010. The pilot air causes pneumatic ON/OFF valve 13010 to open or close to start or stop electrolyte supply to the polishing chamber 13002, as much as necessary for the processes. As shown in Figs. 13A and 13D, the control valve 13004 controls electrolyte flow rate. It operates with pilot air from the pneumatic pressure regulator 13006 that receives signals from control system 13018.

In addition to pneumatic ON/OFF valve 13010 there is another pneumatic ON/OFF valve 13008. The said valve is used to drain electrolyte from the polishing chamber 1002 and from supply line to electrolyte reservoir 13020.

As shown in Figs. 13A and 13D, the control system 13018 uses the actual flow rate from flow meter 13016 and transmits signals to the control valve 13004 to control and regulate the

flow of electrolyte in the supply line. Control system 13018 relays signals to pneumatic pressure regulator 13006, which can increase or decrease the pressure of pilot air to the control valve 13004 to cause it to pass more or less electrolyte to achieve the desired flow rate. If pneumatic pressure regulator 13006 receives no signal from control system it will set the pilot air to zero and control valve 13004 is closed.

If electrolyte were to go to polishing chamber 13002, pneumatic ON/OFF valve 13008 will close, and both control valve 13004 and pneumatic ON/OFF valve 13010 will open. To bypass polishing chamber 13002 and deliver electrolyte back to electrolyte reservoir 13020, pneumatic ON/OFF valves 13008 and 13010 open while control valve 13004 is closed.

When control valve 13004 closes, the excess volume of electrolyte that is lodged in the supply line between control valve 13004 and pneumatic ON/OFF valve 13010 can return to electrolyte reservoir 13020 through pneumatic ON/OFF valve 13008. In particular, to redirect electrolyte that is lodged in the supply line to electrolyte reservoir 13020, pneumatic ON/OFF valve 13008 will be opened. As shown in Figs. 13A and 13D, open pneumatic ON/OFF valve 13008 allows electrolyte to be redirected back to electrolyte reservoir 13020.

Fig. 14 shows a further detailed flow system control diagram. It consists of computer 14000, digital/analog (D/A) and analog/digital converter (A/D) 14002, and electrical current controlled pneumatic pressure regulator or IP converter 14006

Flow look-up table generation

Step 1. Computer 14000 sends command to IP converter to generate one Nth of full pressure; N is number in the range of 5 to 100, preferably 30.

Step 2. Computer 14000 records the flow rate through A/D converter 14002.

Step 3. Computer 14000 sends command to IP converter to generate two Nth of full pressure.

Step 4. Computer 14000 records the flow rate through A/D converter 14002.

Step 5. Repeat steps 3 and 4 for point 3, 4,,,,, N-1, N separately, as shown in Table 1 below:

Table 1 Flow look-up table

Point 1			Point n-1	Point n			Point N
P_0*1/N			P_0*(n-1)/N	P_0*n/N			P_0
Flow (1)			Flow (n-1)	Flow (n)			Flow (N)

For a flow rate f0, computer will search in the table to find a range Flow (n-1) and Flow (n) so that Flow (n-1) < f0 < Flow (n). Then computer will calculate the pressure P1 as follows:

$$P1 = P0*(n-1)/N + (f0 - Flow\ (n-1)) * ((P0*n/N) - P0*(n-1)/N))/(Flow\ (n) - Flow\ (n-1)) \qquad (1)$$

This initial calculated pressure set point P1 will be sent to control valve 13004 and brings the flow rate to the closest desired flow value f1.

If the flow rate f1 is different from f0, the following formula can be used to correct the flow rate again.

$$P2 = P1 + (f0 - f1) *((P0*n/N) - P0*(n-1)/N)) / (Flow\ (n) - Flow\ (n-1)) \qquad (2)$$

Then a continuous measurement is taken repeatedly to increase or decrease pressure in the control valve 13004 to maintain a flow rate closest to the desired set point.

The look-up table as shown in Table 1 can be regenerated or updated periodically depending upon the stability of control valve 13004, the A/D and D/A converter 14002, and IP converter 13006.

The method described here is useful when upstream or down stream pressure varies during operation.

III. TEMPERATURE IMPACT TO POLISHING EFFICIENCY

Fig. 10 shows the relationship between polishing efficiency and temperature at a constant contact area of electrolyte column with wafer. As temperature increases, the polishing efficiency increases due to the chemical effect of electrolyte. As we discussed previously, the temperature of electrolyte has been used as a variable to adjust physical viscosity in order to have stable contact area of electrolyte column with wafer. In order to compensate the temperature impact to polishing efficiency, electrical current adjustment can be used according to the present invention based on pre-calibrated data shown in Fig. 10 and Fig. 3. For instance, when temperature of electrolyte due to viscosity adjustment increases, the electrical current can be slightly reduced to compensate it. The current can se set as follows:

$$I = I_0 - \frac{I_0\left(\frac{d\rho(T_0, I_0)}{dT}\right)dT}{\rho(T_0, I_0) + \frac{d\rho(T_0, I_0)}{dI} I_0} \qquad (3)$$

Where, I_0 is the set point of electrical current, T_0 is temperature set point of electrolyte, dT is the temperature deviation from set point T_0, and $\rho(T, I)$ is the polishing efficiency function.

Gas Bubble Removal

Gas bubbles (oxygen and hydrogen) are generated during the electrical polishing process. The bubbles will be mixed with electrolyte and flowing back to electrolyte reservoir. The bubble will move to surface of electrolyte as they flow in to outlet. If the bubbles are re-pumped back to nozzle with electrolyte, they will reduce the effective contact area of electrolyte column with wafer. Therefore, the removal rate will reduce. In order to remove bubbles from electrolyte before being re-pumped back to polishing chamber, two dividers 11078 and 11080 are placed inside the reservoir as shown in Fig. 11 B. Two dividers are placed from bottom of reservoir to

above electrolyte surface; therefore electrolyte will follow the tunnel formed by two dividers. This will uniformly prolong the returned electrolyte to reach the outlet area. In order words, the gas bubbles will have enough time to raise to surface of electrolyte when they travel to outlet portion of reservoir 11076.

For a detailed description on a filtering mechanism for gas bubbles, see U.S. Provisional Application Ser. No. 60/462,642, entitled METHODS AND APPARATUS FOR OPTIMIZING ELECTROPOLISHER, filed on April 14, 2003, which is incorporated in its entirety by reference herein.

Various aspects of the present invention disclosed herein can be used in variety of electropolishing mechanisms as shown in Figs. 12A to 12F. In general, both nozzle 12032 and wafer chuck 12020 can be stationary or moveable, and the wafer surface can be face up, or face down, or face side. The following table 1 summary the detail features:

Table 2. Variety of electropolishing mechanism

	Fig. 12A	Fig. 12B	Fig. 12C	Fig. 12D	Fig. 12E	Fig. 12F
Stationary Chuck				Yes	Yes	Yes
Movable Nozzle				Yes	Yes	Yes
Movable Chuck	Yes	Yes	Yes			
Stationary Nozzle	Yes	Yes	Yes			
Chuck Face	Side	Down	Up	Side	Down	Up

The above detailed description of various devices, methods, and systems used to improve removal rate uniformity during electropolishing is provided to illustrate exemplary embodiments and is not intended to be limiting. It will be apparent to those skilled in the art that numerous modifications and variations within the scope of the present inventions are possible. Therefore,

the present invention should not be construed as being limited to the specific forms shown in the drawings and described above.

Title: Methods and Apparatus for Controlling the Removal Rate During Electropolishing
Inventor: Hui WANG
Filed: Herewith
Sheet 1 of 18

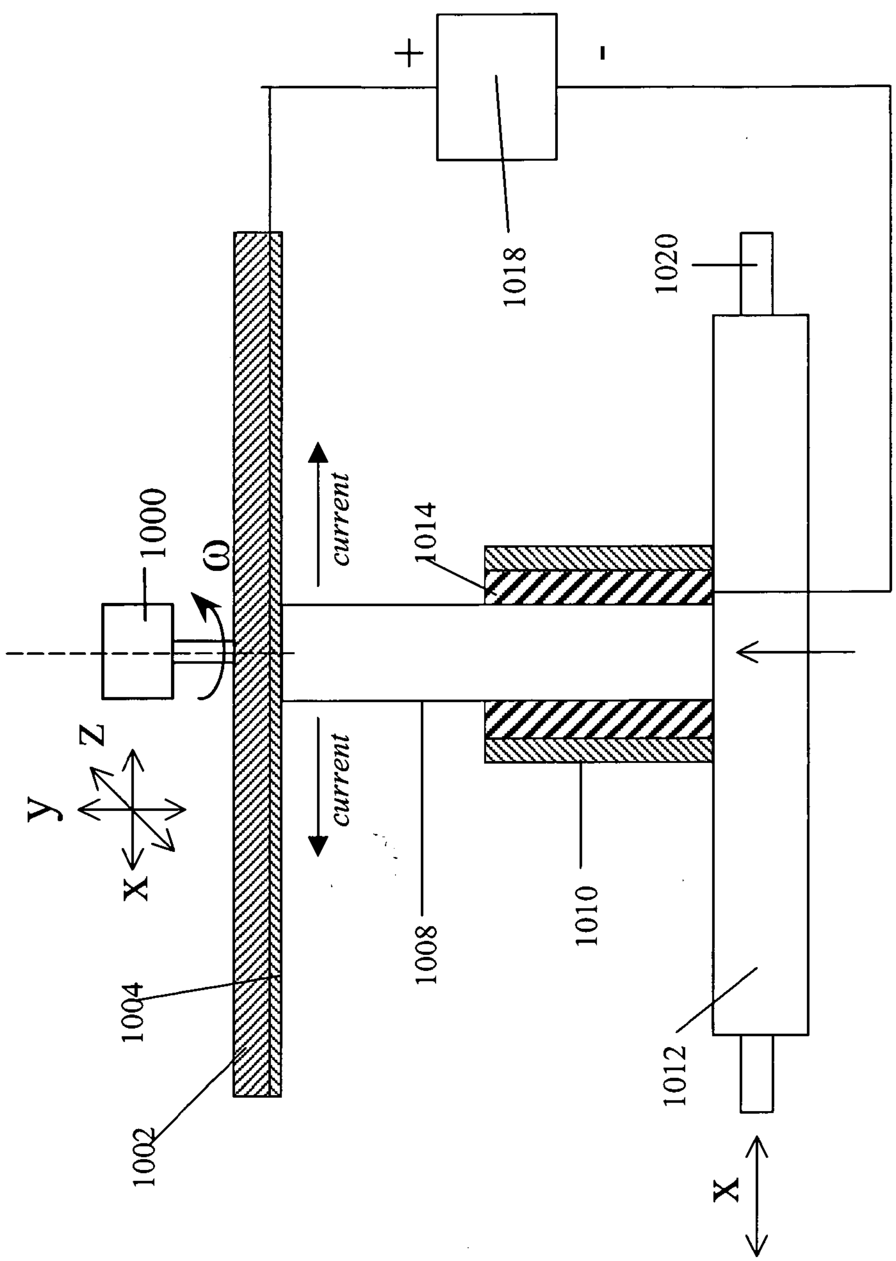

Fig. 1

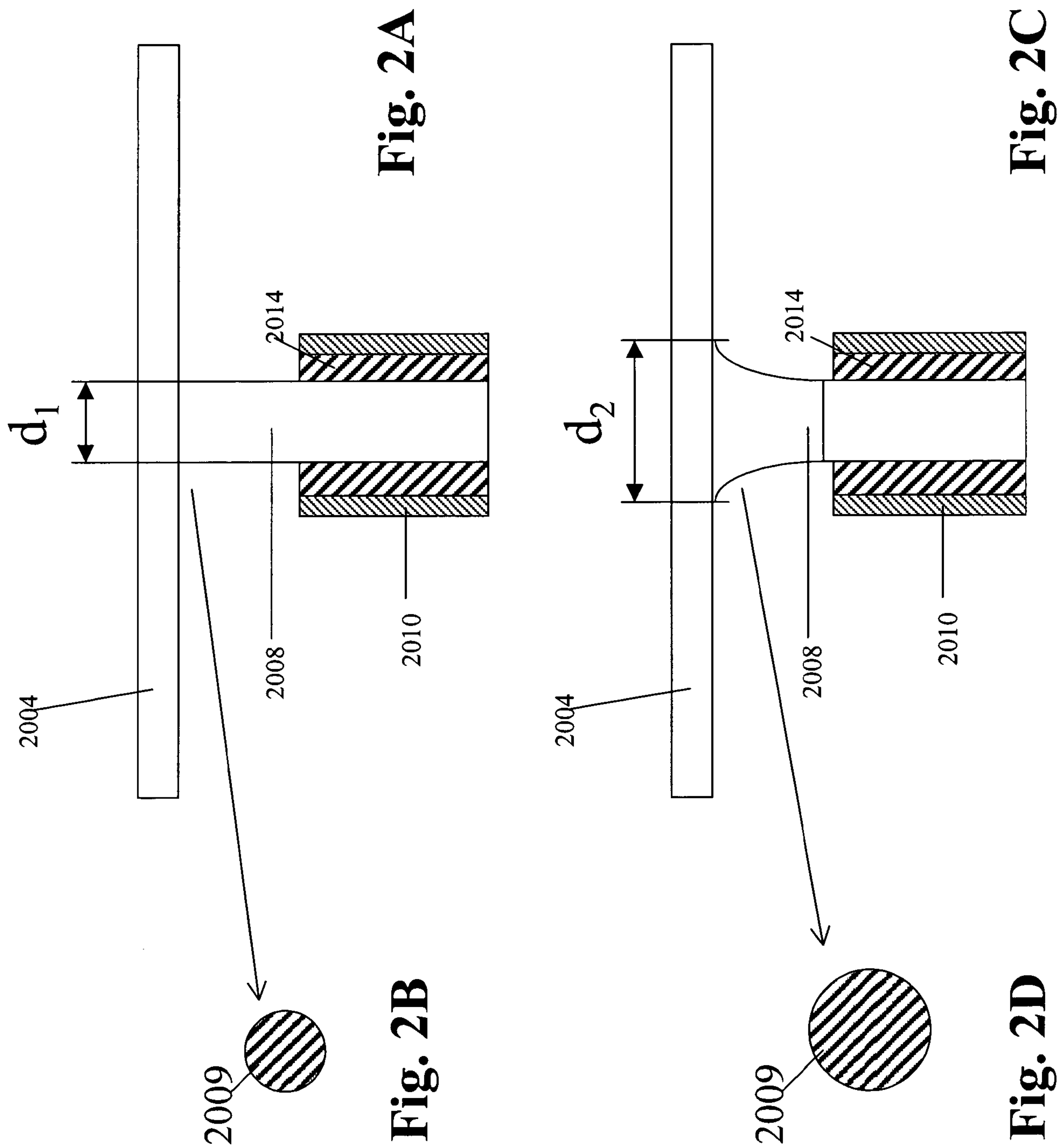

Fig. 2A

Fig. 2B

Fig. 2C

Fig. 2D

Title: Methods and Apparatus for Controlling the Removal Rate During Electropolishing
Inventor: Hui WANG
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Sheet 3 of 18

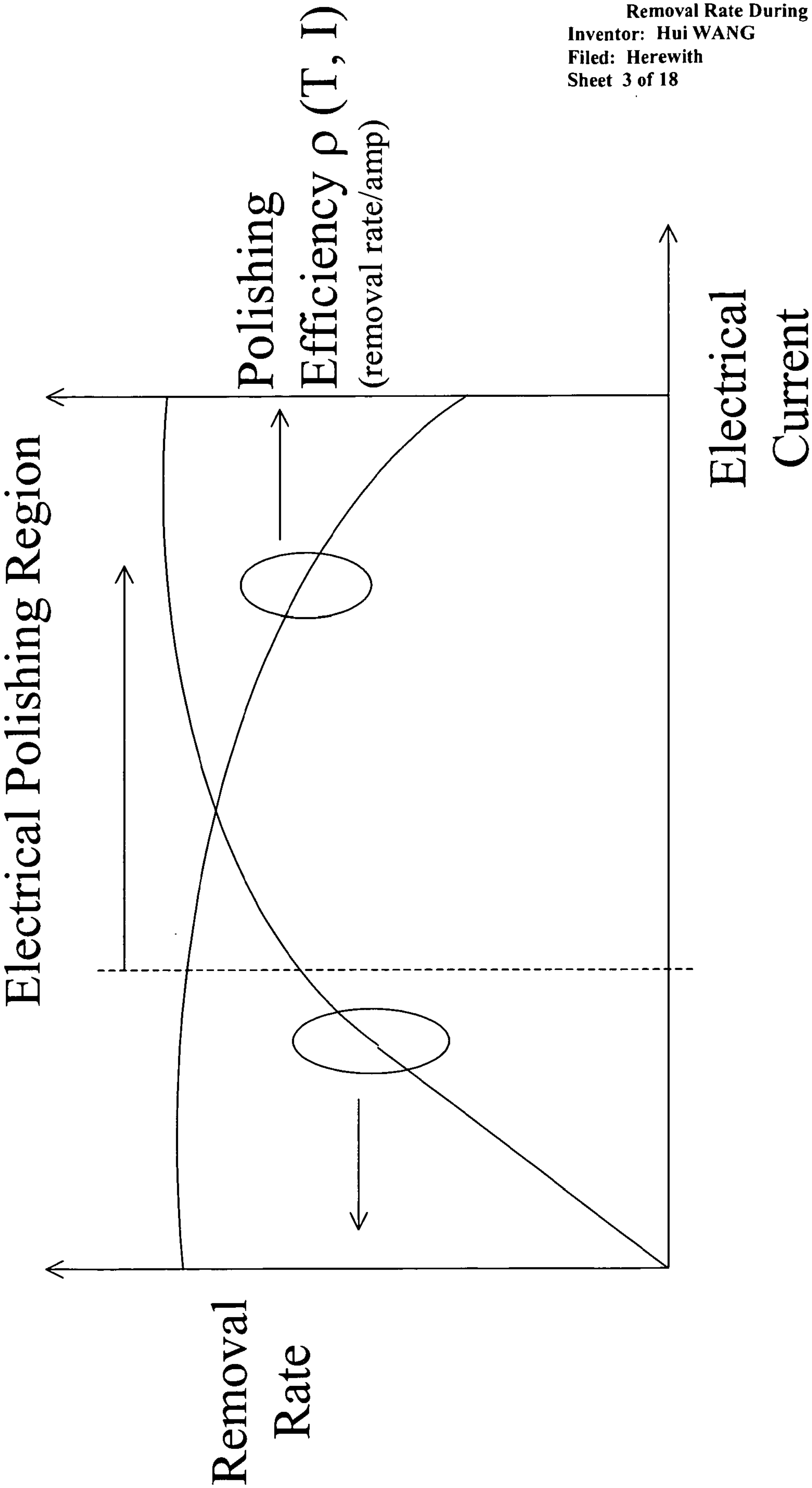

Fig. 3

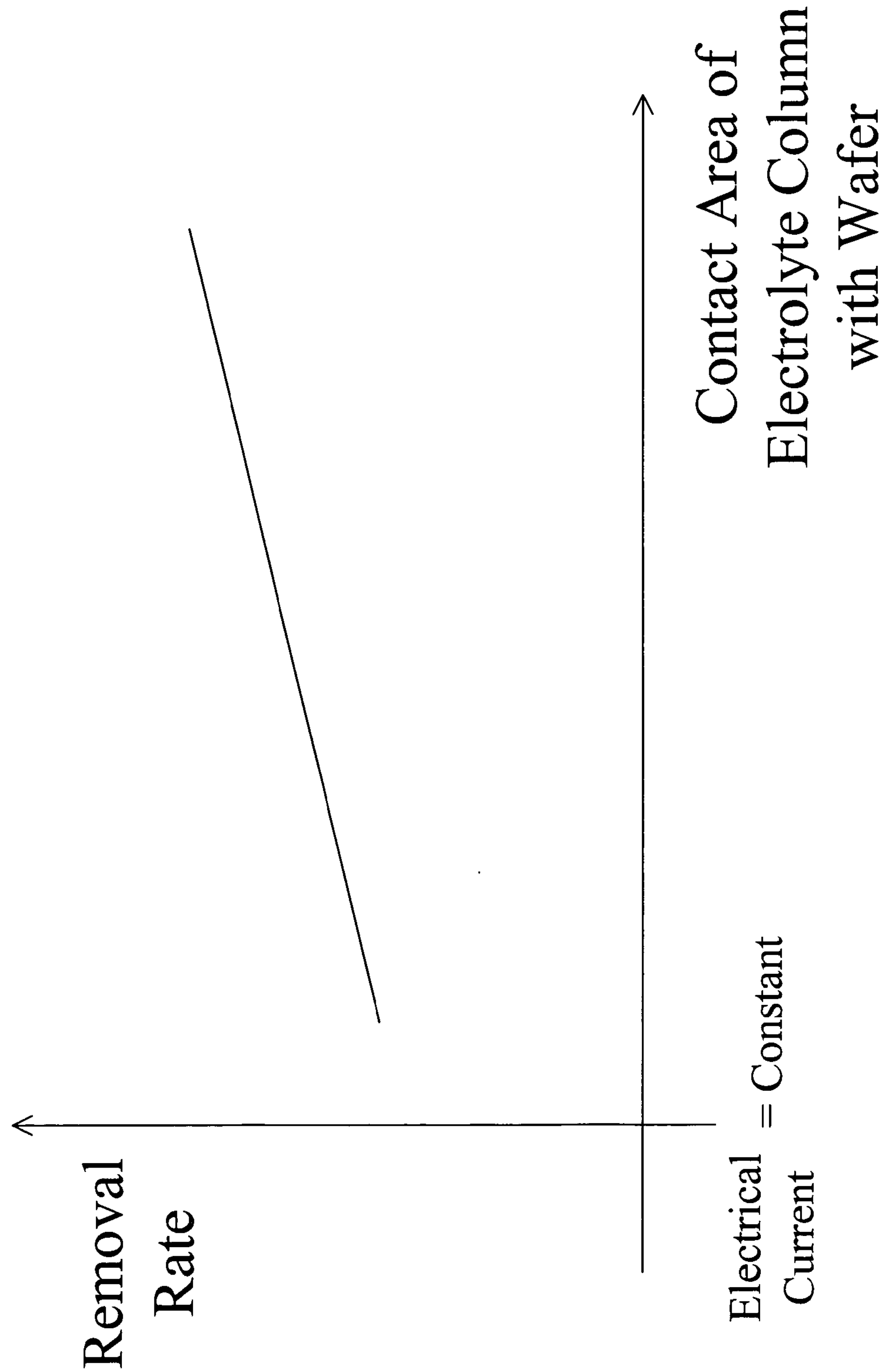
Removal Rate
Contact Area of Electrolyte Column with Wafer
Electrical Current = Constant

Fig. 4

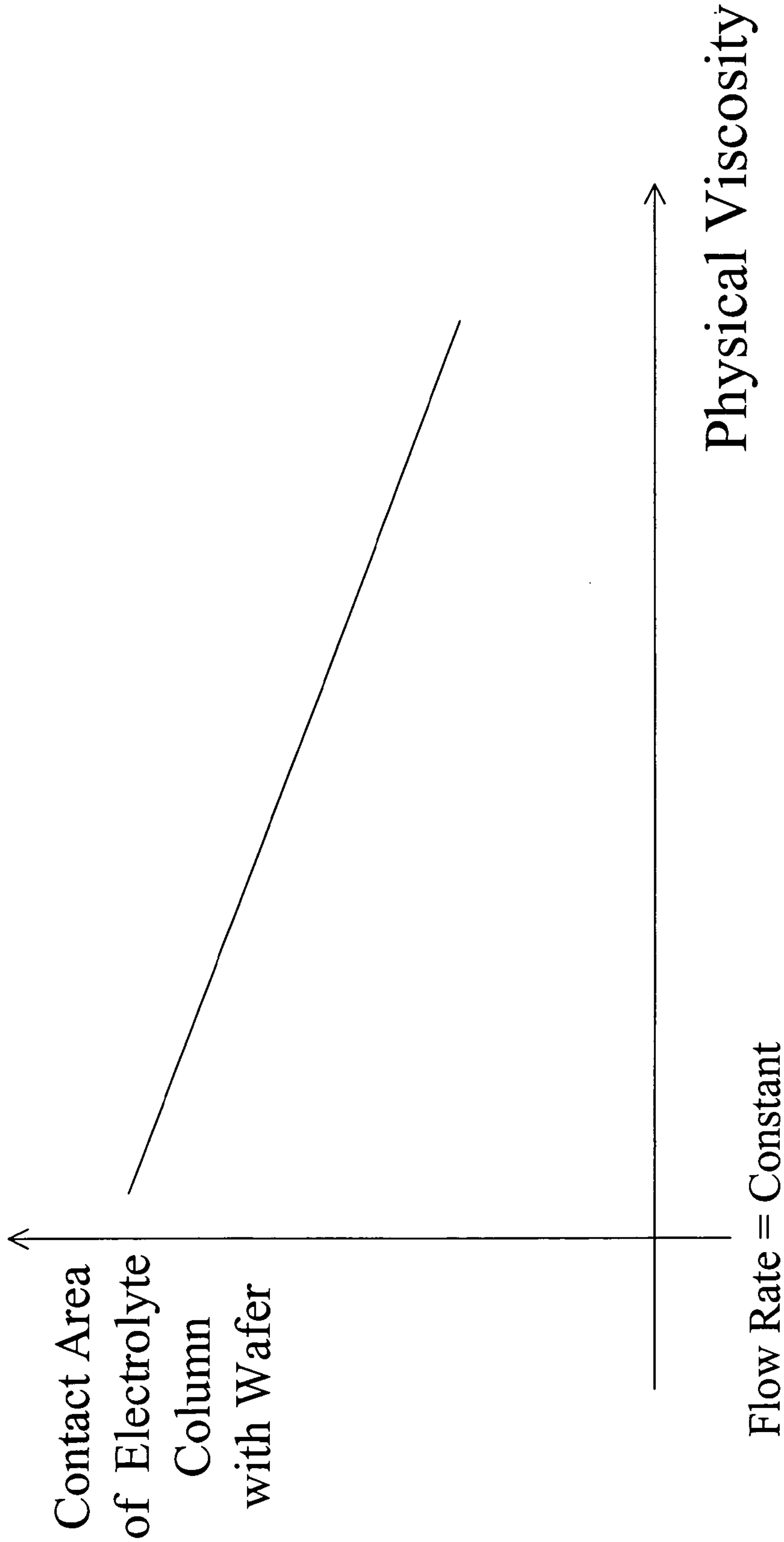
Contact Area of Electrolyte Column with Wafer
Flow Rate = Constant
Physical Viscosity

Fig. 5

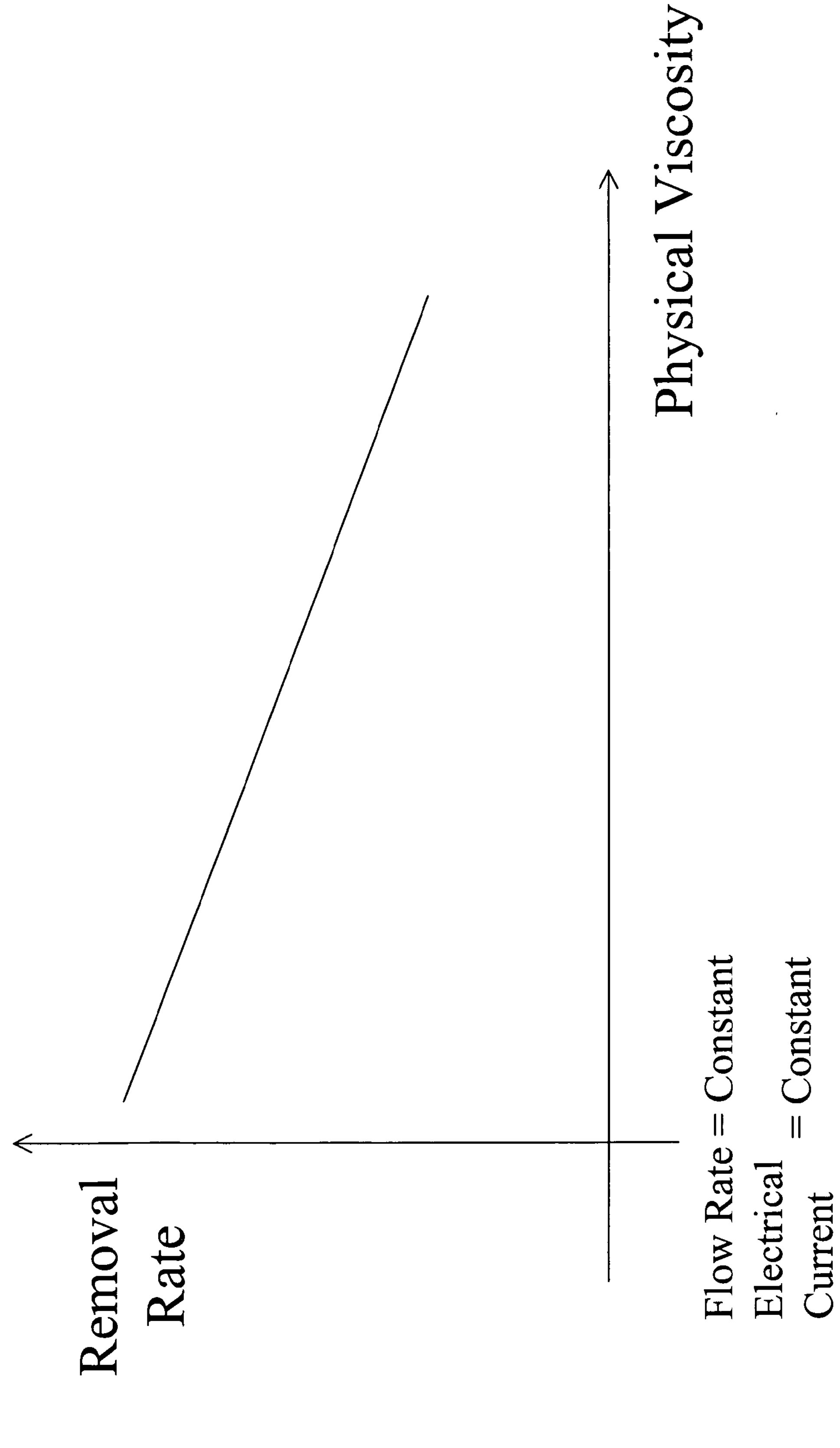
Removal Rate
Physical Viscosity
Flow Rate = Constant
Electrical Current = Constant

Fig. 6

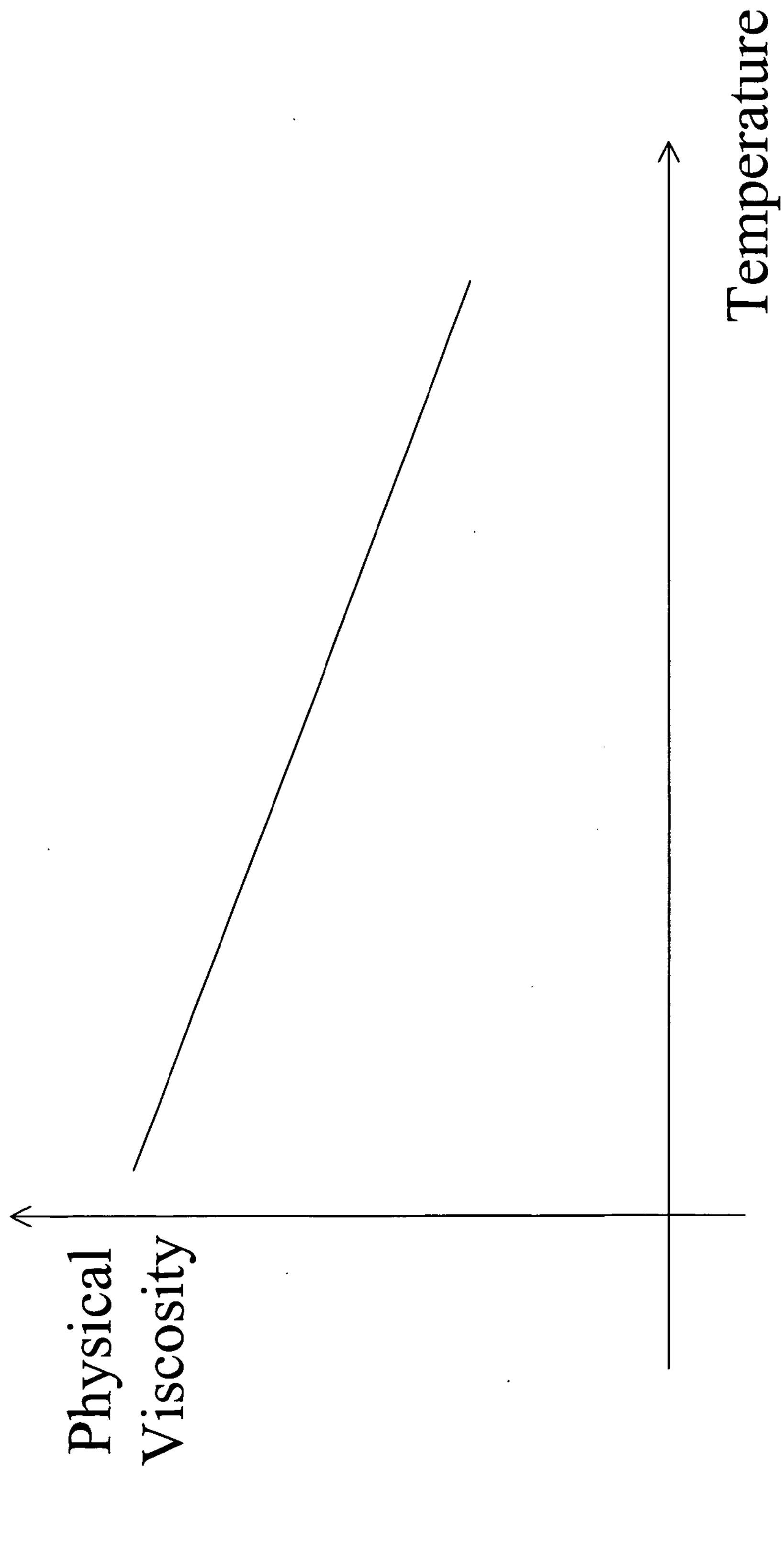

Fig. 7

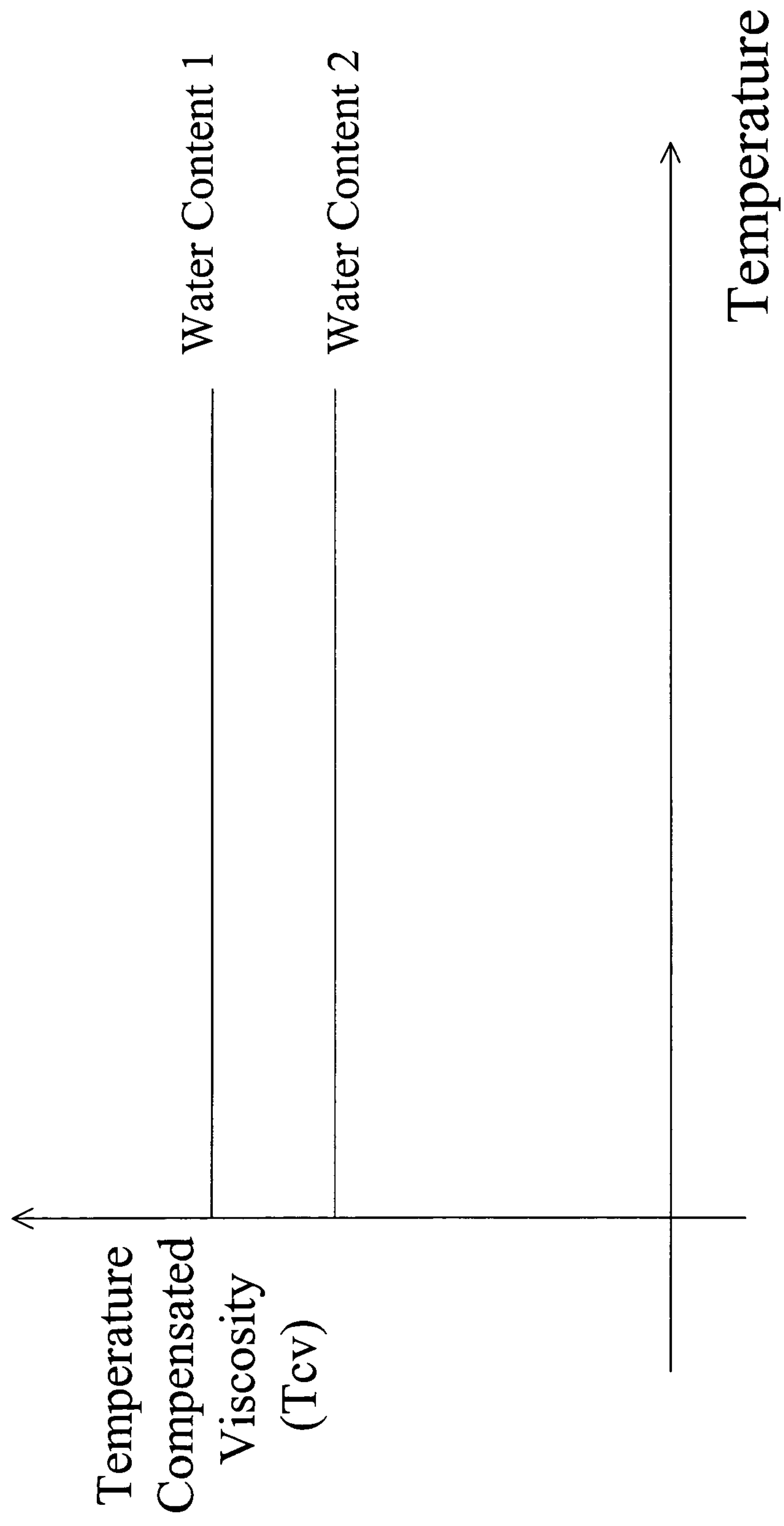
Water Content 1
Water Content 2
Temperature
Temperature Compensated Viscosity (Tcv)

Fig. 8

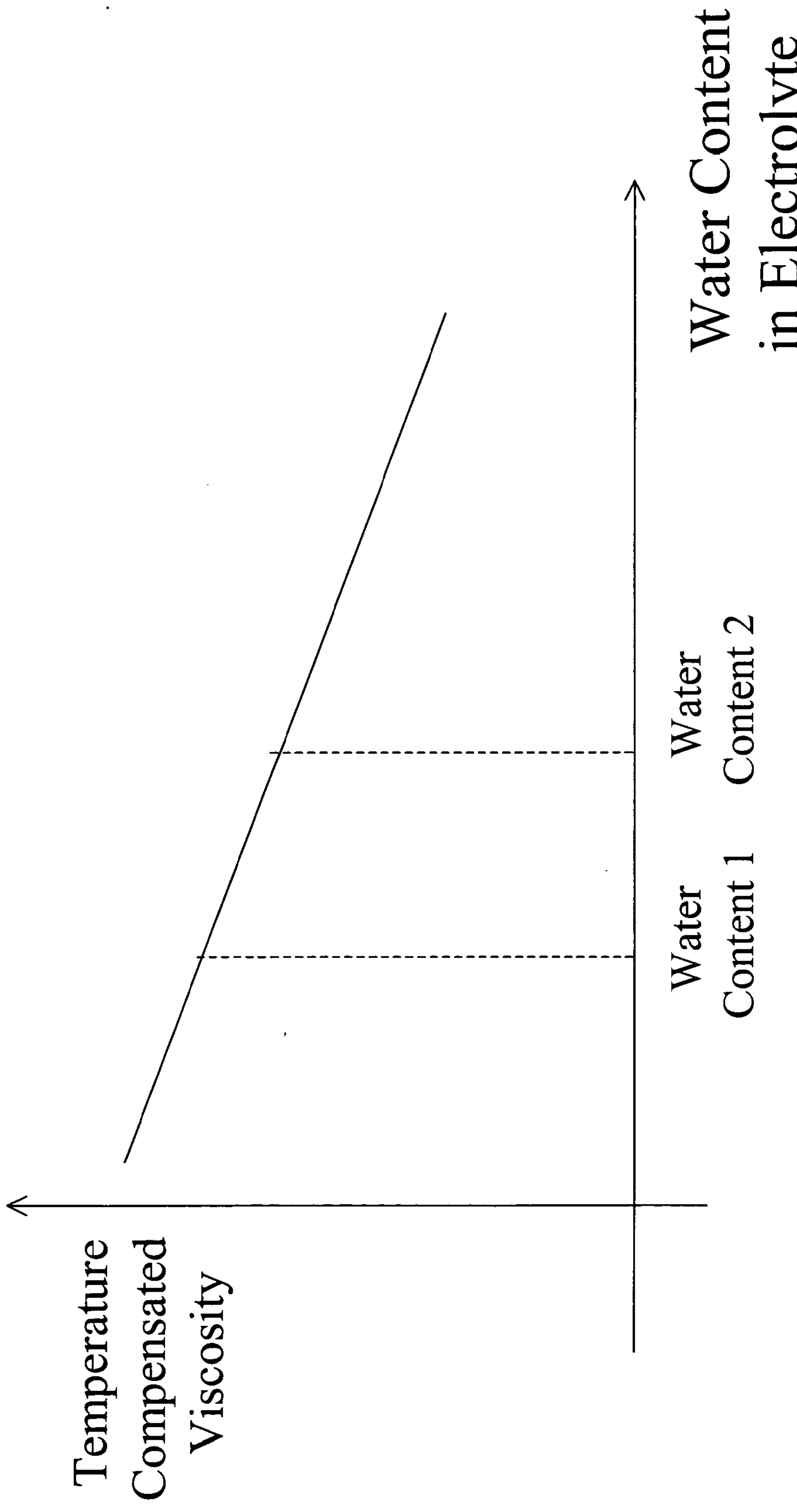
Water Content in Electrolyte
Water Content 2
Water Content 1
Temperature Compensated Viscosity

Fig. 9

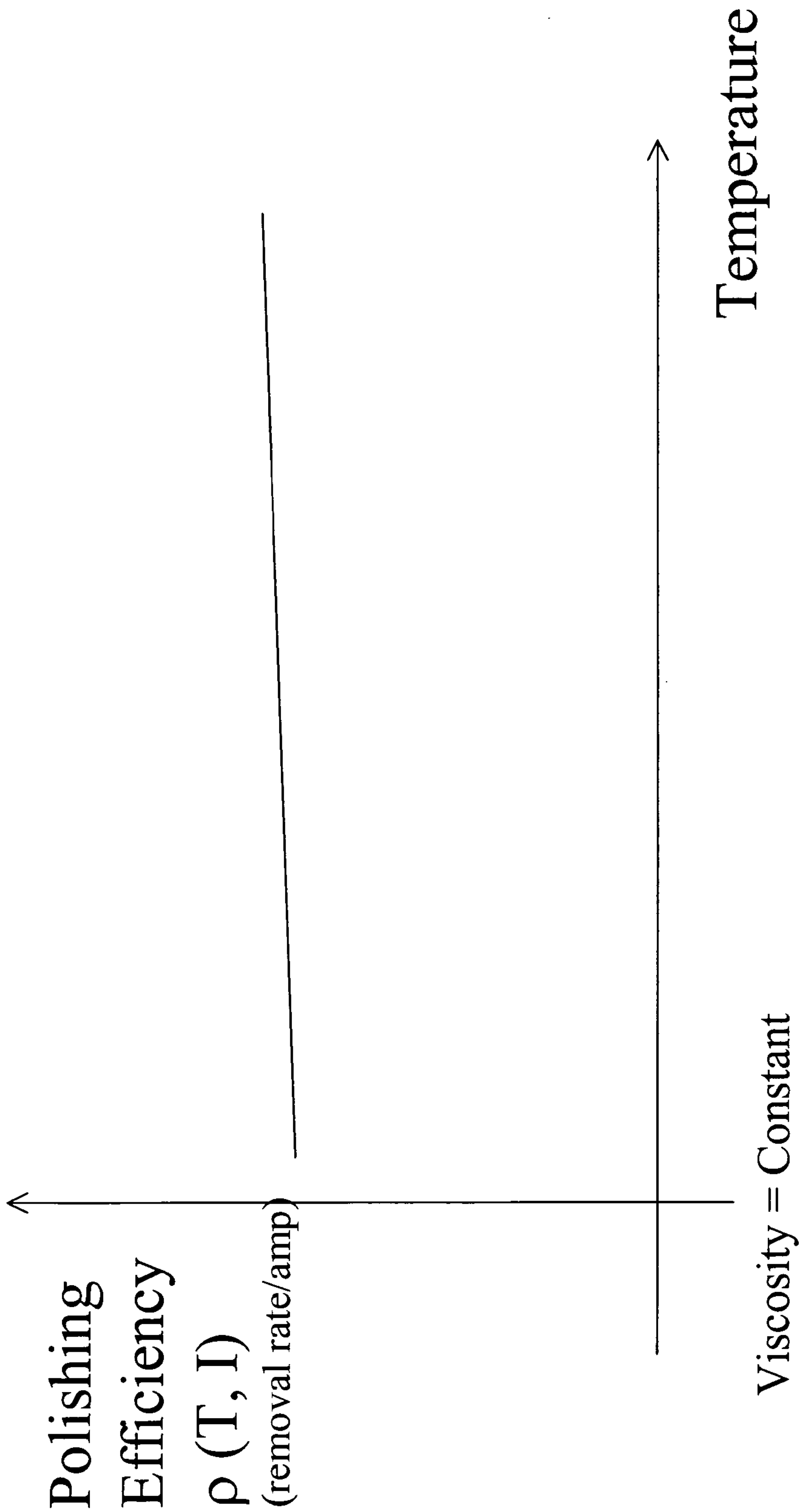
Polishing
Efficiency
ρ (T, I)
(removal rate/amp)
Temperature
Viscosity = Constant

Fig. 10

Title: Methods and Apparatus for Controlling the Removal Rate During Electropolishing
Inventor: Hui WANG
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Sheet 11 of 18

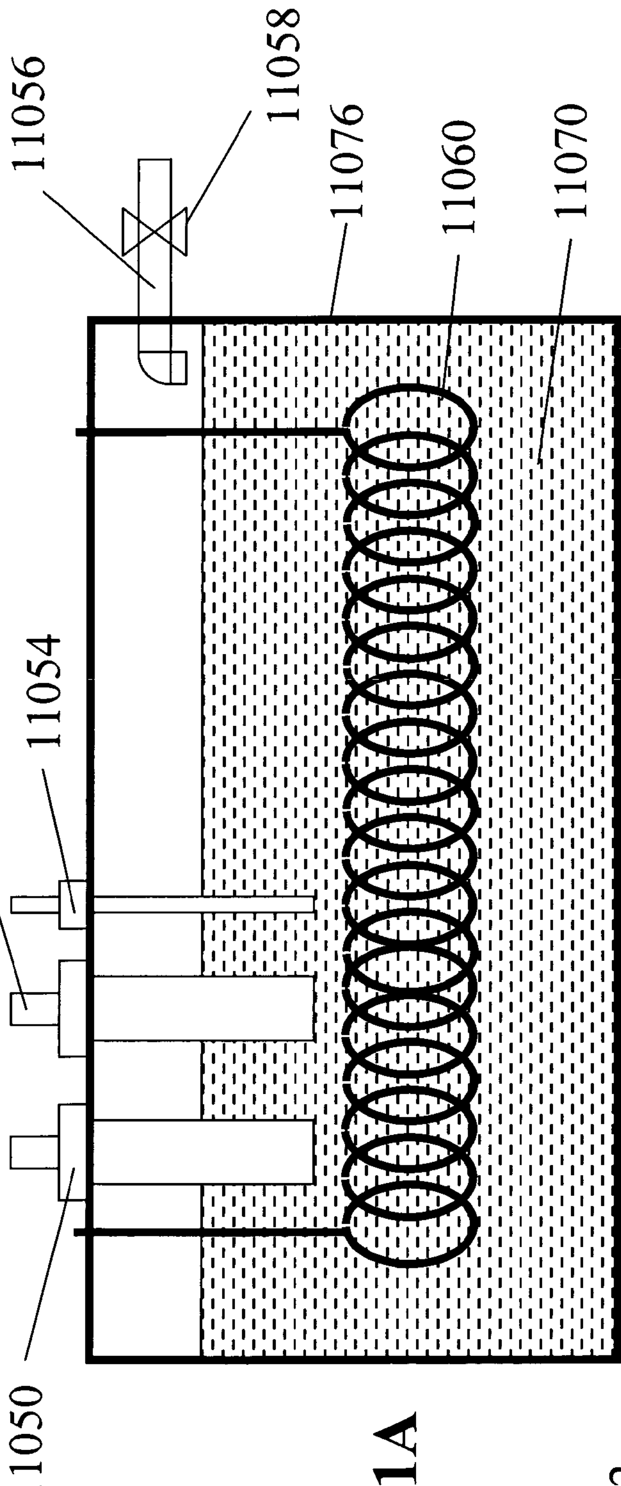


Fig. 11A

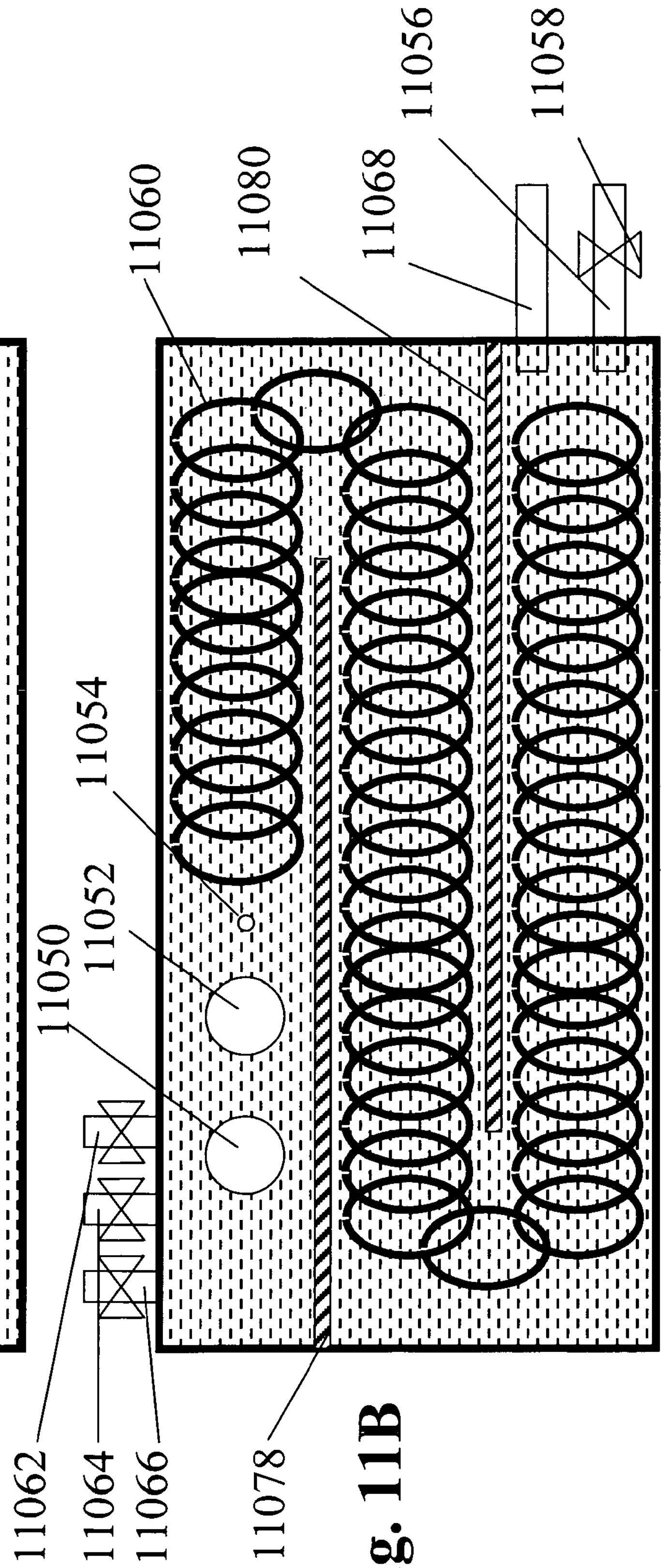


Fig. 11B

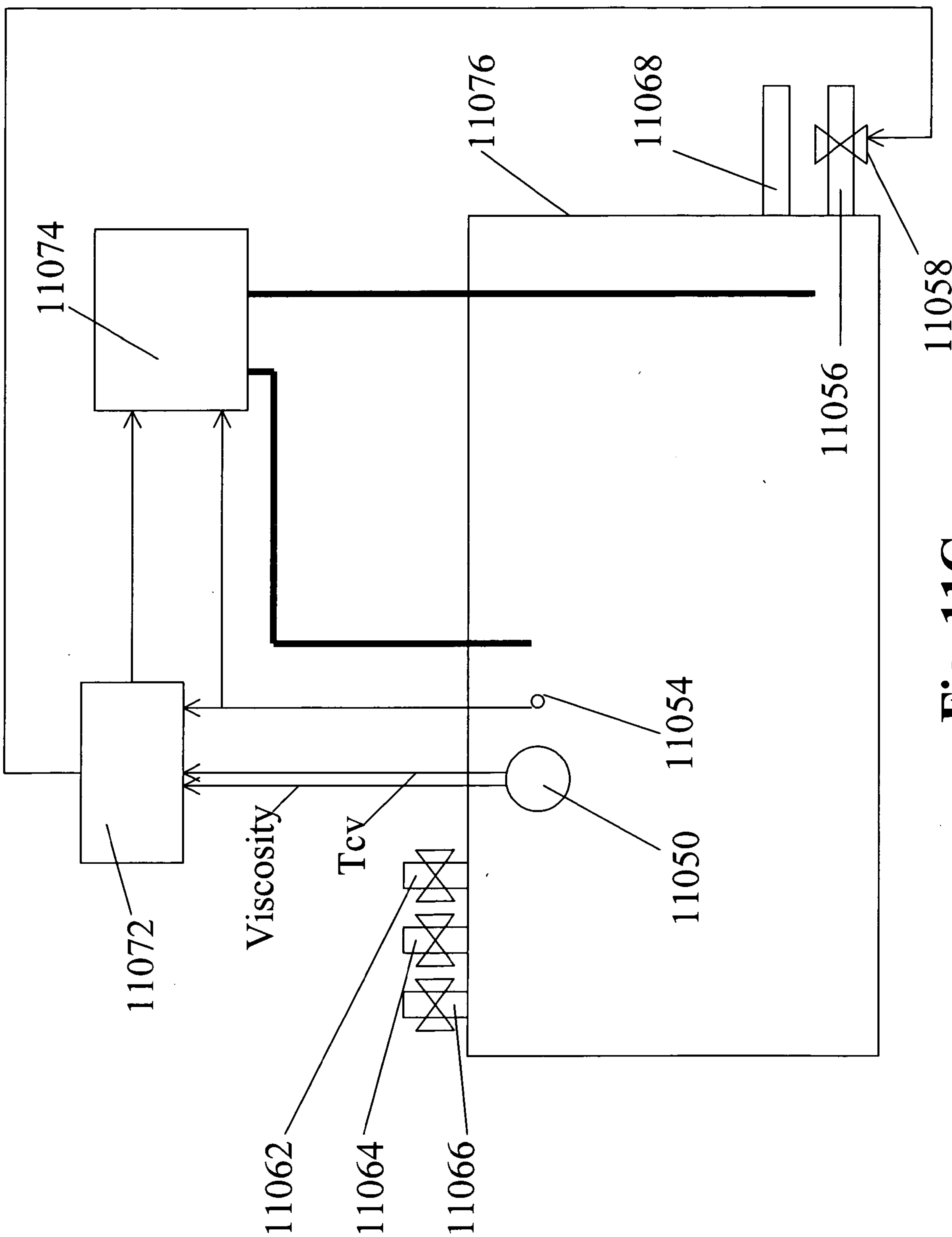

11076
11068
11074
11058
11056
11054
11050
11072
Viscosity
Tcv
11062
11064
11066

Fig. 11C

Title: Methods and Apparatus for Controlling the Removal Rate During Electropolishing
Inventor: Hui WANG
Filed: Herewith
Sheet, 13 of 18

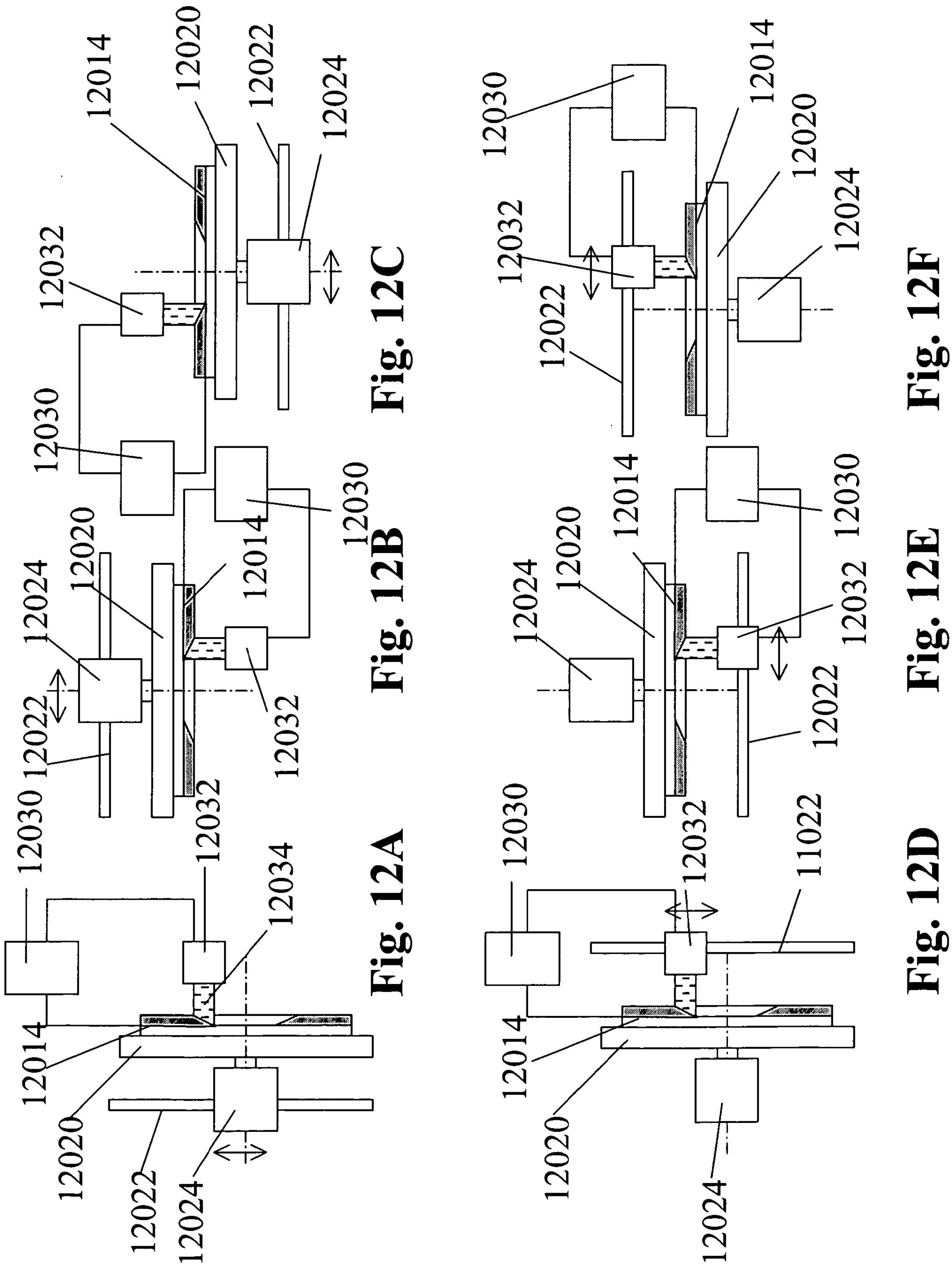


Fig. 12A

Fig. 12B

Fig. 12C

Fig. 12D

Fig. 12E

Fig. 12F

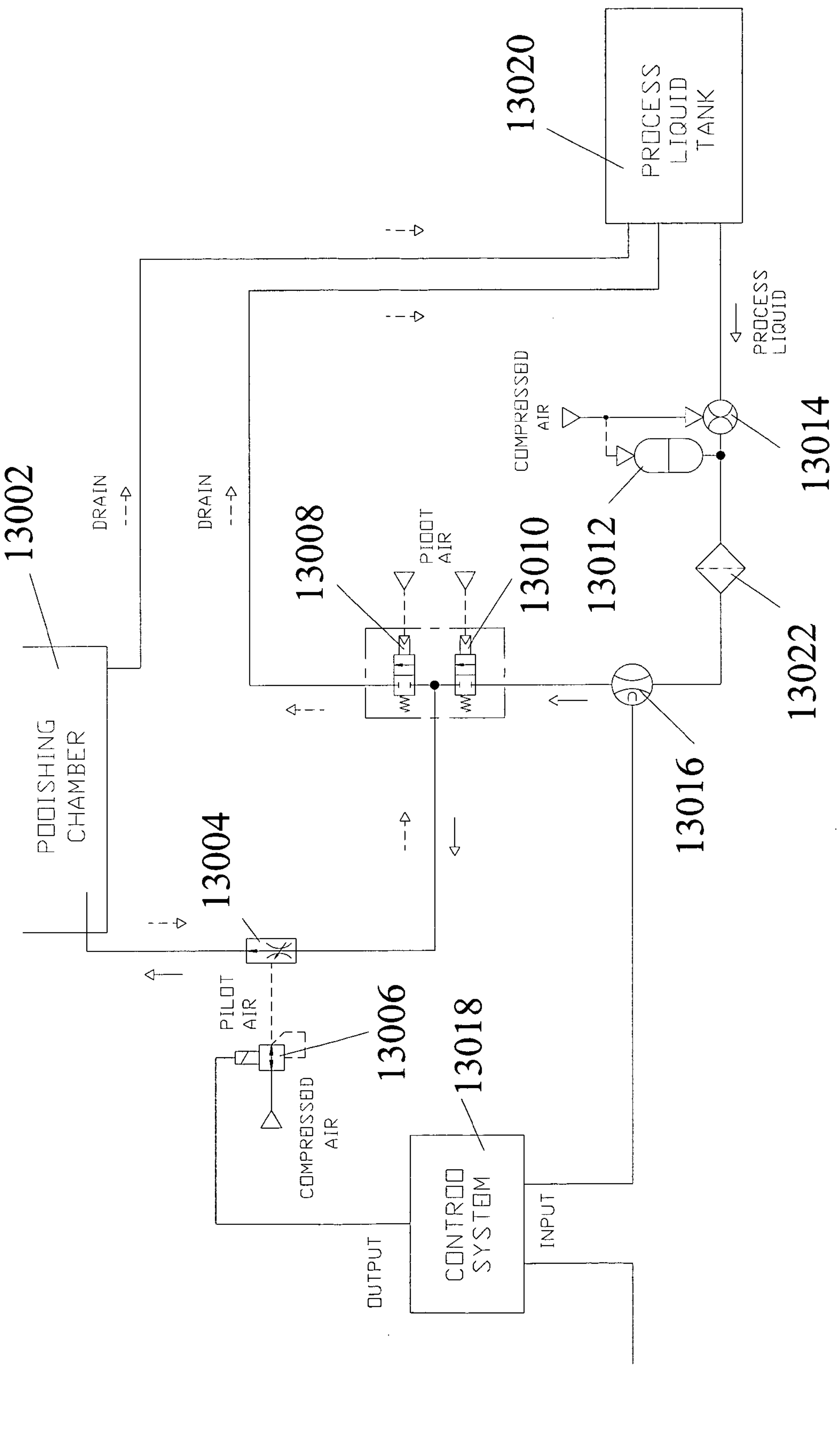

13020
PROCESS LIQUID TANK
PROCESS LIQUID
COMPRESSED AIR
13014
13012
13022
13002
DRAIN
DRAIN
13008
PILOT AIR
13010
13016
CHAMBER
13004
PILOT AIR
13006
13018
COMPRESSED AIR
SYSTEM
INPUT
OUTPUT

Fig. 13A

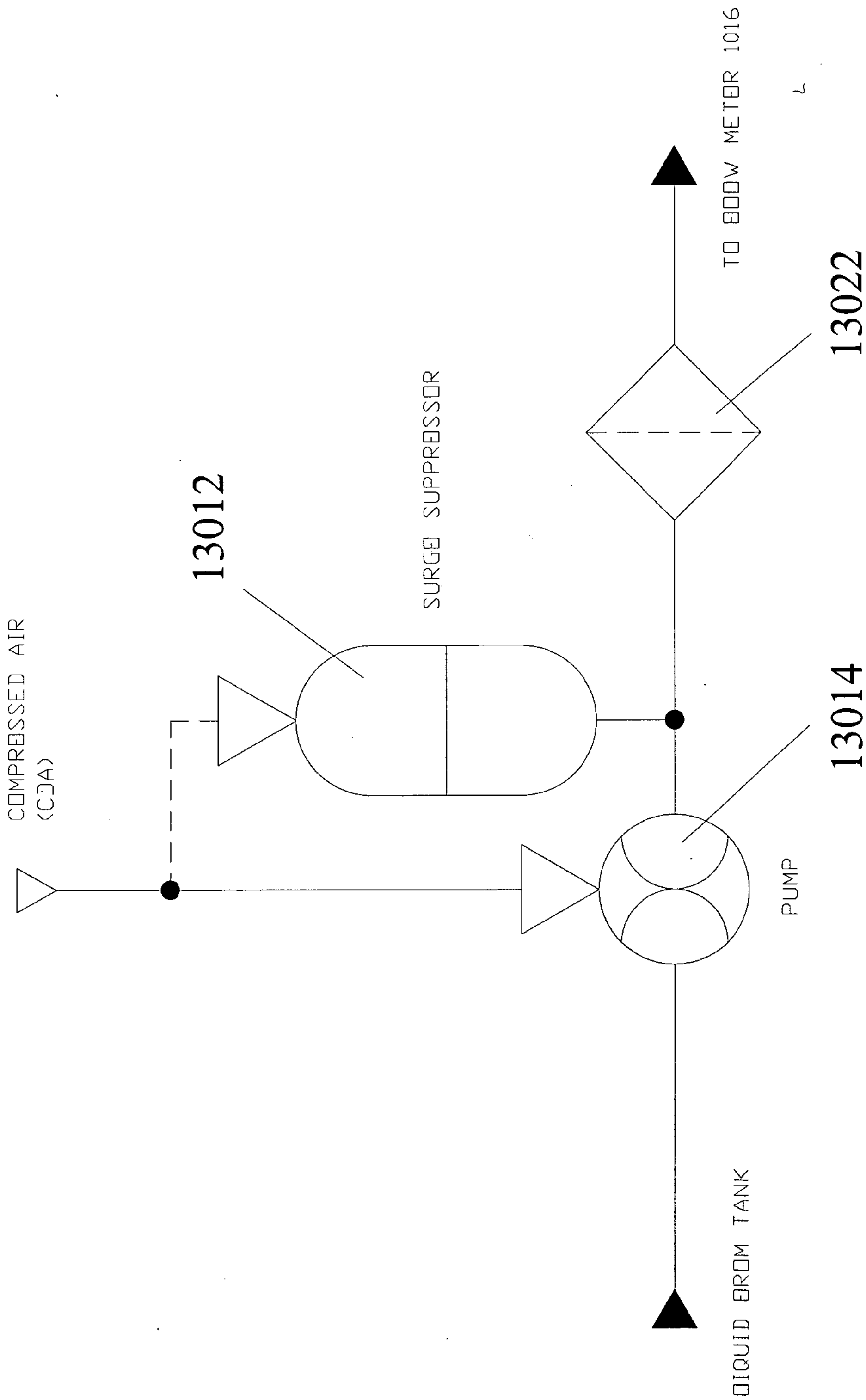

COMPRESSED AIR
(CDA)
13012
SURGE SUPPRESSOR
13014
PUMP
13022
TO FLOW METER 1016
LIQUID FROM TANK

Fig. 13B

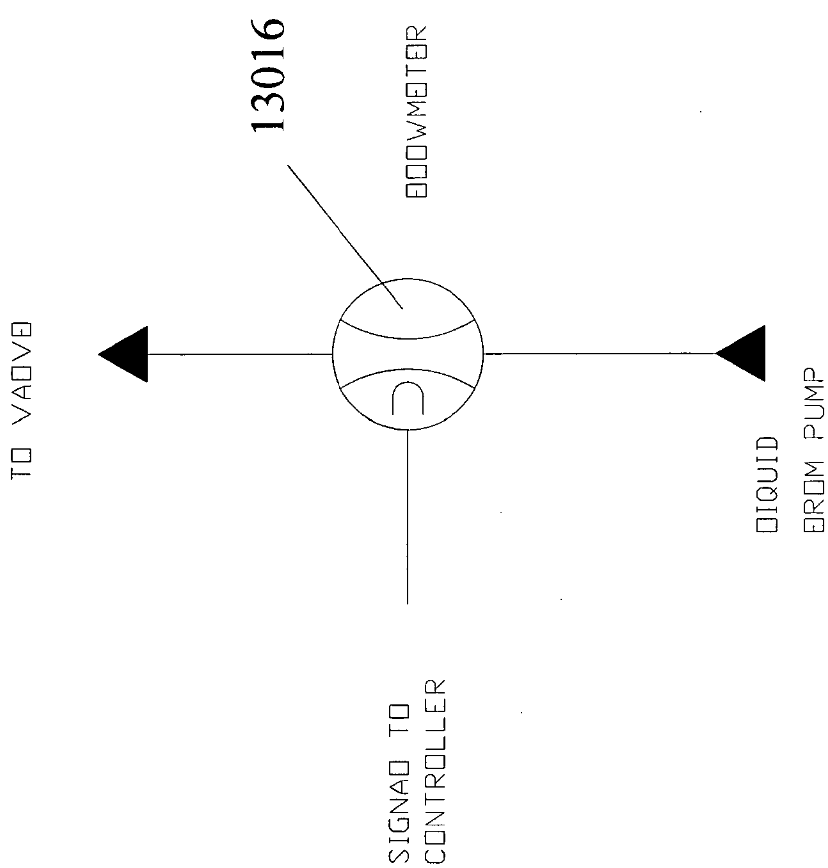

13016
FLOWMETER
TO VALVE
LIQUID
FROM PUMP
SIGNAL TO
CONTROLLER

Fig. 13C

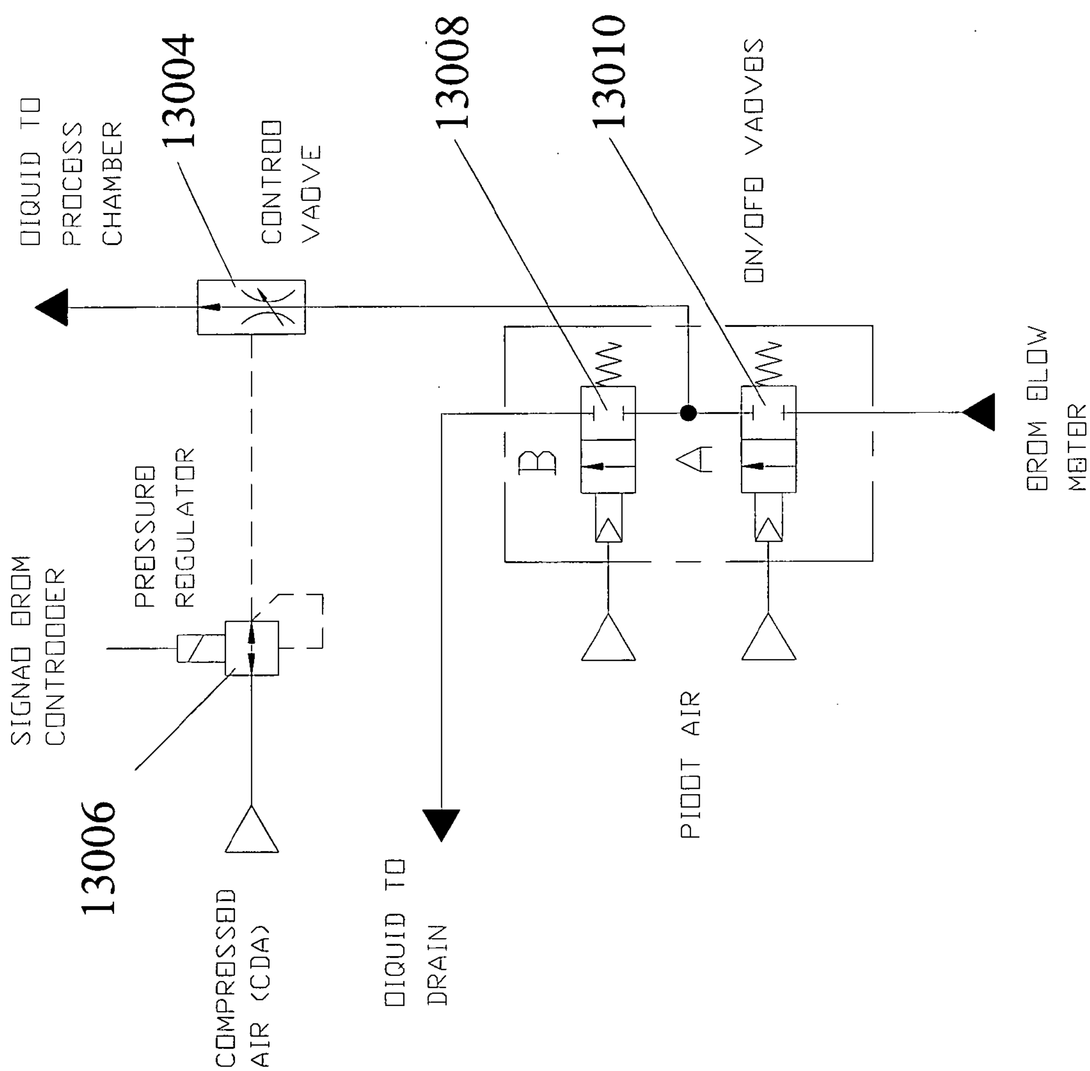
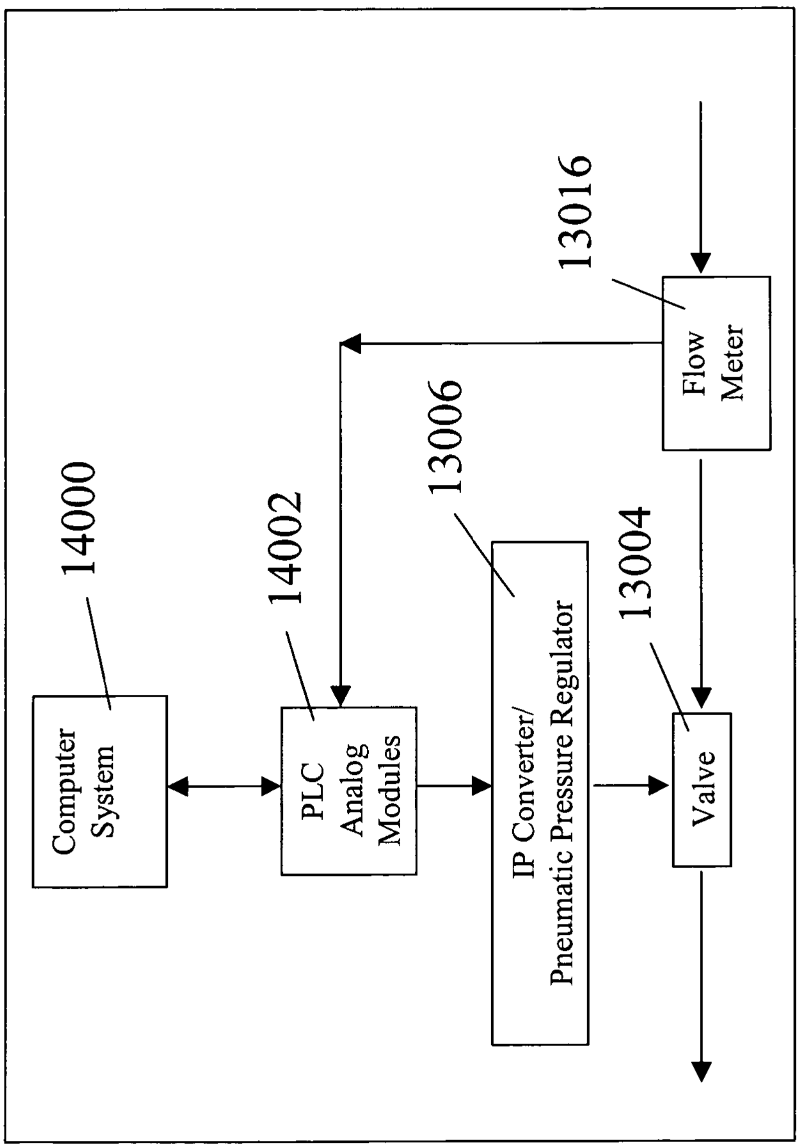

LIQUID TO PROCESS CHAMBER
13004
CONTROL VALVE
13008
13010
ON/OFF VALVES
B
A
FROM FLOW METER
SIGNAL FROM CONTROLLER
PRESSURE REGULATOR
13006
COMPRESSED AIR (CDA)
LIQUID TO DRAIN
PILOT AIR

Fig. 13D



Note -

IP Converter: Current to pressure converter
Pneumatic Pressure Regulator: Voltage to pressure converter
Control System may use IP Converter or Pneumatic Pressure Regulator

Fig. 14

Application Data Sheet

Application Information

Application Type::	Provisional
Subject Matter::	Utility
Suggested classification::	
Suggested Group Art Unit::	
CD-ROM or CD-R?::	
Number of CD disks::	
Number of copies of CDs::	
Sequence submission?::	
Computer Readable Form (CRF)?::	
Number of copies of CRF::	
Title::	Methods and Apparatus for Controlling the Removal Rate During Electropolishing
Attorney Docket Number::	
Request for Early Publication?::	
Request for Non-Publication?::	
Suggested Drawing Figure::	
Total Drawing Sheets::	18
Small Entity?::	Yes
Petition included?::	
Petition Type::	

Applicant Information

Applicant Authority Type::	Inventor
Primary Citizenship Country::	USA
Status::	Full Capacity
Given Name::	HUI
Middle Name::	
Family Name::	WANG

Name Suffix::	
City of Residence::	Fremont
State or Province of Residence::	CA
Country of Residence::	USA
Street of mailing address::	46520 Fremont Blvd., Suite 610
City of mailing address::	Fremont
State or Province of mailing address::	CA
Postal or Zip Code of mailing address::	94538
Applicant Authority Type::	Inventor
Primary Citizenship Country::	USA
Status::	Full Capacity
Given Name::	MUHAMMED
Middle Name::	
Family Name::	AFNAN
Name Suffix::	
City of Residence::	Dalian
State or Province of Residence::	LIAONING PROVINCE
Country of Residence::	CHINA
Street of mailing address::	46520 Fremont Blvd., Suite 610
City of mailing address::	Fremont
State or Province of mailing address::	CA
Postal or Zip Code of mailing address::	94538
Applicant Authority Type::	Inventor
Primary Citizenship Country::	CHINA
Status::	Full Capacity
Given Name::	JIAN
Middle Name::	
Family Name::	WANG
Name Suffix::	
City of Residence::	Fremont
State or Province of Residence::	CA

Country of Residence:: USA

Street of mailing address:: 46520 Fremont Blvd., Suite 610

City of mailing address:: Fremont

State or Province of mailing address:: CA

Postal or Zip Code of mailing address:: 94538

Applicant Authority Type:: Inventor

Primary Citizenship Country:: USA

Status:: Full Capacity

Given Name:: FELIX

Middle Name::

Family Name:: GUTMAN

Name Suffix::

City of Residence:: San Jose

State or Province of Residence:: CA

Country of Residence:: USA

Street of mailing address:: 46520 Fremont Blvd., Suite 610

City of mailing address:: Fremont

State or Province of mailing address:: CA

Postal or Zip Code of mailing address:: 94538

Applicant Authority Type:: Inventor

Primary Citizenship Country:: USA

Status:: Full Capacity

Given Name:: FREDRICK

Middle Name::

Family Name:: HO

Name Suffix::

City of Residence:: San Jose

State or Province of Residence:: CA

Country of Residence:: USA

Street of mailing address:: 46520 Fremont Blvd., Suite 610

City of mailing address:: Fremont

State or Province of mailing address:: CA

Postal or Zip Code of mailing address:: 94538

Applicant Authority Type:: Inventor

Primary Citizenship Country:: USA

Status:: Full Capacity

Given Name:: HIMANSHU

Middle Name:: J.

Family Name:: CHOKSHI

Name Suffix::

City of Residence:: Fremont

State or Province of Residence:: CA

Country of Residence:: USA

Street of mailing address:: 46520 Fremont Blvd., Suite 610

City of mailing address:: Fremont

State or Province of mailing address:: CA

Postal or Zip Code of mailing address:: 94538

Correspondence Information

Correspondence Customer Number::

Name:: David Hui Wang, ACM Research, Inc.

Street of mailing address:: 46520 Fremont Blvd., Suite 610

City of mailing address:: Fremont

State or Province of mailing address:: CA

Country of mailing address:: USA

Postal or Zip Code of mailing address:: 94538

Phone number:: (510) 445-3700

Fax number:: (510) 445-3708, (510) 445-3655

E-Mail address:: dwang@acmrc.com

Representative Information

Representative Designation::	Registration number::	Name::
Primary	44417	Peter J. Yim

Domestic Priority Information

Application::	Continuity Type::	Parent Application::	Parent Filing Date::

Foreign Priority Information

Country::	Application number::	Filing Date::	Priority Claimed::

Assignment Information

Assignee name:: ACM Research, Inc.

Street of mailing address:: 46520 Fremont Blvd., Suite 610

City of mailing address:: Fremont

State or Province of mailing address:: CA

Country of mailing address:: USA

Postal or Zip Code of mailing address:: 94538